SWORN TESTIMONY OF JASPER HARDESTY

STATE OF NEW MEXICO)
) ss:
COUNTY OF BERNALILLO)

I, Jasper "Joe" Hardesty, being duly sworn on oath depose and state the following to be true and correct to the best of my knowledge and belief:

1. I'm over the age of 21 and competent to make this affidavit as well as testify about the matters contained in this affidavit.
2. I have been asked to opine about carbon dioxide (CO2) and whether CO2 in the supercritical phase is the same or synonymous with CO2 in the liquid phase, and more specifically, whether supercritical CO2 is a different phase than liquid CO2 or liquefied CO2.
3. My opinions and testimony here relate specifically to the proposed CO2 pipeline by Summit Carbon Solutions, LLC, and SCS Carbon Transport, LLC, herein collectively referred to as Summit or SCS.

EDUCATION AND BACKGROUND

4. I have three Chemical Engineering degrees, including a Bachelor of Science from the University of New Mexico, a Master of Science from Stanford University, and a Ph.D. also from Stanford University. I also have an earlier Bachelor of Science Degree in Architecture from the University of Illinois, and I retain an active Professional License in Architecture.

   I have more than thirty years of experience in chemical engineering and architecture, both in private-sector firms and at the U.S. Department of Energy's Sandia National Laboratories. I have extensive design and management experience in all aspects of major institutional, commercial, and industrial construction projects. I have conducted scientific research in biofuels, microfluidics, microsensors, interfacial surface science, and biocatalysis (protein and enzymatic reactions). I have supported research in food supply-chain security, decontamination technologies, critical infrastructure resilience, energy and water

resources, building resilience, atmospheric science, laboratory safety and security, and Arctic change and security implications. I have conducted research on biofuels from algae via supercritical steam (hydrothermal) processing.

I have managed U.S. federal projects in chemical and biological safety and security for industries and governing institutions in approximately 15 countries across the Middle East, Africa, Southeast Asia, and the Pacific. I have worked on design, development, analysis, and testing of methods for response and recovery to chemical and biological disasters and worked with municipal authorities in the U.S. to develop detailed guidance on their infrastructure response and recovery plans. I have managed research programs and construction projects for atmospheric research facilities and climate change in the Artic and other U.S. locations. I also serve as a member of the American Institute of Architects Safety Assessment Program for post-disaster building assessment, accredited via the California Office of Emergency Services.

DATA AND INFORMATION PROVIDED

5. I was provided and reviewed the following data and/or documentation prior to formulating my opinions stated herein:

   a. May 9, 2023, testimony of SCS Carbon Transport LLC's expert pipeline witness John Godfrey, as provided to the North Dakota Public Service Commission in SCS's support of their pending "Application for Certificate of Corridor Compatibility and Route Permit and Waiver" for the portion of their proposed hazardous carbon dioxide pipeline in North Dakota. This testimony was provided by Mr. Godfrey under penalty of perjury. A link to the video and audio of this testimony is at https://www.youtube.com/watch?v=xZLyL-VhyXI and a link to audio of these North Dakota proceedings can also be found on the North Dakota PSC website at: https://apps.psc.nd.gov/webapps/cases/psdocketdetail?getId=22&getId2=39

1&getId3=212# Mr. Godfrey holds a BS in General Engineering from the University of Illinois.

b. Testimony from April 11, 2023, of SCS Carbon Transport LLC's Chief Operating Officer, Jimmy Powell, as provided to the North Dakota Public Service Commission in SCS's support of their pending "Application for Certificate of Corridor Compatibility and Route Permit and Waiver" for their portion of their proposed hazardous carbon dioxide pipeline in North Dakota. This testimony was provided by Mr. Powell under penalty of perjury. https://www.youtube.com/watch?v=f4vP9qtr06E&t=2612s and a link to audio only of this testimony is found on the North Dakota PSC docket at: https://apps.psc.nd.gov/webapps/cases/psdocketdetail?getId=22&getId2=391&getId3=179#

6. I was also provided a copy of Iowa Code § 479B.2(4) and § 479B.2(2). To be clear, I am not offering legal opinions but rather scientific opinions to assist in further framing the nature of the present dispute. However, I understand argument has been made that SCS/Summit is not a pipeline company for the purposes of Iowa Code chapter 479B because in § 479B.2(4) "Pipeline company" means a person engaged in or organized for the purpose of owning, operating, or controlling pipelines for the transportation or transmission of any hazardous liquid or underground storage facilities for the underground storage of any hazardous liquid." And in § 479.2(2), "Hazardous liquid" means crude oil, refined petroleum products, liquefied petroleum gases, anhydrous ammonia, liquid fertilizers, **liquefied carbon dioxide**, alcohols, and coal slurries." (emphasis added).

ADDITIONAL INFORMATION CONSIDERED

7. Mr. Micah Rorie, testifying for Summit on May 16, 2023, in the trial in question here, testified to his belief that Summit will be transporting CO2 in the dense phase, however he admitted he did not have the technical expertise to explain what dense phase CO2 is or is not.

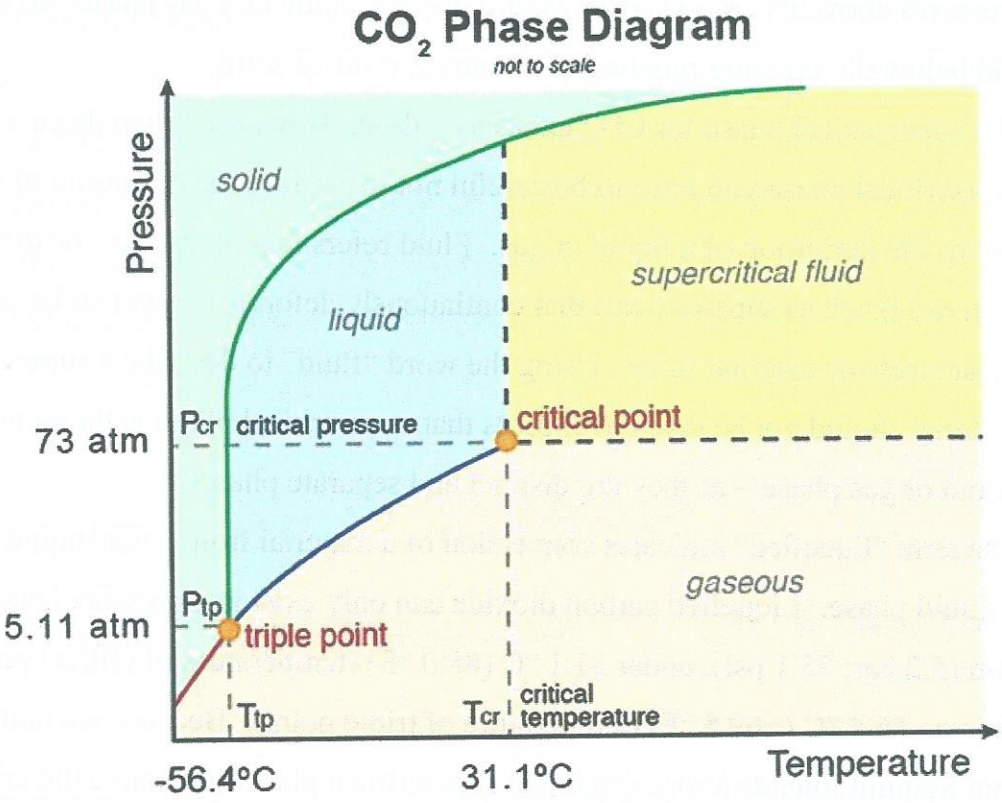
8. Mr. Jimmy Powell's North Dakota PSC testimony, at https://www.youtube.com/watch?v=f4vP9qtr06E&t=2612s at 50:23 to 50:30 he claimed that Summit will be transporting "dense phase supercritical CO2 that is under pressure".
9. Mr. John Godfrey's North Dakota PSC testimony, captured at https://www.youtube.com/watch?v=xZLyL-VhyXI starting at 32:10 and concluding at 32:50, where he discusses the Pipeline and Hazardous Material Safety Administration (PHMSA) existing regulations only apply to CO2 transported by pipeline in the supercritical phase, as Summit intends to do, and states the PHMSA does not currently have regulations as to CO2 transported in the either the gas phase or liquid phase.
10. I was asked to assume as true that PHMSA currently exercises no jurisdiction over pipelines transporting CO2 as a gas or liquid, and only regulates CO2 pipelines with a concentration of more than 90% carbon dioxide compressed to supercritical state, rendering any pipeline moving CO2 in any other state or with less than 90% purity entirely unregulated by the federal pipeline administration.[1]

OPINIONS

11. My opinions are provided here to a reasonable degree of professional engineering certainty and are based upon my education, training, background, and experience.
12. If I assume Mr. Godfrey's testimony to be true regarding that current PHMSA guidelines as to CO2 pipelines cover supercritical phase CO2 transportation but not liquid or gas phase CO2 transportation – the reasonable conclusion is that PHMSA is aware of the scientific fact that supercritical phase CO2 is different from liquid phase CO2. This is consistent with my opinion in that the supercritical phase CO2 that Summit would operate under is different from liquid phase transportation of CO2 – as the phases are distinctly different.

[1] https://pstrust.org/wp-content/uploads/2022/03/CO2-Pipeline-Backgrounder-Final.pdf; and https://www.ecfr.gov/current/title-49/subtitle-B/chapter-I/subchapter-D/part-195/subpart-A/section-195.2

13. Most people are aware of three (3) basic states or phases of matter – solid, liquid, and gas. States are also referred to as phases, and the terms "state" and "phase" are often used interchangeably in this context. Persons involved with the currently proposed CO2 pipelines may also be familiar with another state of matter – the supercritical phase. This is a phase that is neither gas nor liquid. The supercritical phase is not a liquid phase, and has different properties than the liquid phase. The supercritical phase describes a separate state of matter that exists at (and above) the intersection of specific temperature and pressure known as the critical point.
14. To illustrate different states of CO2 and the intersection of pressure and temperature that creates the critical point where CO2 phases change, the diagram that follows is helpful.



Phase Diagram for Pure Carbon Dioxide

Units notes: Triple Point = (-69.5) °F and 75.1 psi; Critical Point = 88 °F and 1,073 psi
(°F = degrees Fahrenheit, psi = pounds per square inch)
[Source: Harvard Online: https://www.labxchange.org/library/items/lb:LabXchange:8e3f616b:html:1]

15. As shown in the phase diagram, the temperature and pressure utilized in the storage or conveyance of CO2 affects its state (or phase). The supercritical fluid state of pure CO2 is maintained only if specific temperature and pressure combinations are adhered to as shown above. The supercritical state of CO2 is how Summit has indicated it would operate its proposed pipeline.
16. The critical point as shown above is the intersection of 31.1 degrees Celsius and a pressure of 73 atm, or approximately 88 degrees F and 1,073 PSI.
17. When CO2 exceeds the critical point through the combination of pressure and temperature applied, CO2 is no longer in the liquid or gas state and instead is in the different and distinct supercritical fluid state. As noted above and seen in the Phase Diagram for Pure CO2, a supercritical fluid exists at temperatures and pressures above its critical point, where distinct liquid and gas phases do not exist, and below the pressure required to compress it into a solid.
18. The supercritical phase for CO2 exists as a fluid. However, when discussing the supercritical phase you have to be careful not to confuse the definition of a fluid versus the definition of a liquid or gas. Fluid refers to a liquid, gas, *or other material* (such as supercritical) that continuously deforms (flows) under an applied shear stress or external force. Using the word "fluid" to describe a supercritical material should not be taken to express that supercritical phase is the same as the liquid or gas phase – as they are distinct and separate phases.
19. The term "liquefied" indicates conversion of a material from a non-liquid phase to a liquid phase. Liquefied carbon dioxide can only exist at a pressure above 5.1 atm (5.2 bar; 75.1 psi), under 31.1 °C (88.0 °F) (temperature of critical point) and above −56.4 °C (−69.5 °F) (temperature of triple point). Because we understand that Summit intends to operate in the supercritical phase and above the critical point – Summit would not be transporting liquefied carbon dioxide according to their own statements.
20. Summit has stated that they will transport CO2 in the supercritical phase. The supercritical phase occurs **above** the critical point temperature. Therefore, by

definition, in that case they would not be transporting liquid carbon dioxide as that phase occurs **below** the critical point.

21. Despite the testimony referenced above of Mr. Rorie and Mr. Powell there is no commonly accepted scientific definition of "dense phase supercritical CO2". While Mr. Godfrey and others in the industry may interchange the terms supercritical and dense to describe a phase or state of CO2, it is not scientifically or factually correct to suggest supercritical phase and dense phase CO2 describe the same single state of matter, particularly "liquefied carbon dioxide" as is designated in the Iowa Code. PHMSA, OSHA and other agencies also recognize that supercritical CO2 is a distinct and separate phase from other phases.

22. Liquid or liquefied carbon dioxide is not the same as supercritical carbon dioxide and does not describe the same state or phase of carbon dioxide as is supercritical carbon dioxide. These are different and distinct phases and not subsets of any same phase. Based upon Summit's own statements and given the scientific facts regarding phases of CO2, their proposed hazardous pipeline would not transport liquid or liquefied carbon dioxide, as liquid carbon dioxide ceases to exist above the critical point – hence the supercritical phase designation.

[redacted]

Jasper "Joe" Hardesty

Signed and sworn before me on May 22, 2023 by Jasper Hardesty.

[redacted]

Notary Public

STATE OF NEW MEXICO
NOTARY PUBLIC
Michaela Davis
Commission No. 1135662
October 06, 2025